Chapter 1

Introduction and Report Background

The connections among weather, climate, and food production have long been recognized and studied. Over the last several decades, it has become increasingly clear that human activities such as fossil-fuel combustion and deforestation are changing the Earth's climate (IPCC 2013). It is likewise clear that these changes have affected and will continue to affect human society, natural ecosystems, and managed ecosystems (IPCC 2013). An extensive body of evidence shows that climate change will continue to have direct and indirect effects on food production throughout the next century (Walthall et al. 2012).

This report builds on previous analyses and assessments of climate change and agriculture to look more broadly at the potential effects of climate change on global food security and examine the implications of these effects for the United States. Food security is defined as "when all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996, 2012a). There are currently about 805 million people, or about 11% of the global population, facing chronic undernourishment (FAO et al. 2014). In 1990–1992, the undernourished population was estimated to be 1.01 billion, or about 19% of the global population (FAO et al. 2014). There has been real improvement over the last several decades, but a significant fraction of the global population still does not get enough food.

The fundamental question addressed by this report is whether this progress can be maintained in the face of changing global climate. Are further improvements in food security achievable? Is climate change likely to threaten and/or reduce food security in the future?

The components of food security are food availability, access, and utilization (including food safety and nutritional value), and the stability of each over time. Addressing the intersection of climate change and each of these components requires consideration of much more than food production; other important food-system activities include food processing, packaging, transporting, storing, trading, wholesaling, retailing, consuming, and waste disposing. It is not possible to understand and characterize the potential effects of climate change on food security without this broad food systems perspective. A systems perspective is needed to address the effects of climate change on global food security and feedbacks to the United States. The United States is tightly connected to the global food system through its role as a major exporter and importer of food, a provider of assistance for many food-insecure nations, and a developer of relevant food technologies and research outputs.

Questions this report will address include the following:

- How are climate and society projected to change in the next 20–30 years and the next 70–100 years? (Chapter 3)
- How might plausible changes in climate and socioeconomic conditions influence the production, consumption, trade, and prices of food? (Chapter 4)
- What are the components of food security and how might climate change affect them? (Chapters 5, 6, and 7)
- How might climate change affect global food security and influence the U.S. food system? (Chapter 8)

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1.1 Report Background

This publication is a comprehensive technical evaluation of the relationship between climate change, global food security, and the U.S. food system. It is a consensus-based assessment conducted by a team of technical experts led by the U.S. Department of Agriculture (USDA). It is based on the peer-reviewed scientific literature and was developed to support U.S. National Climate Assessment (NCA) process, as described in the Global Change Research Act (GCRA) of 1990. In response to stakeholders,

the scope was expanded to include how changes in global climate and food security in other parts of the world could affect the U.S. food system.

Through the USDA's participation in the U.S. Global Change Research Program (USGCRP), this report will help to meet the requirements of the GCRA, which directs agencies to "produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change" and to undertake periodic scientific assessments (United States Code, Title 15, Chapter 56A, 1990). The GCRA requires that the NCA project its findings 25 and 100 years into the future and meet the standards set forth by the Data Quality Act (Public Law 554, 2000). Section 1.4 below describes the types of literature and information used to inform this assessment.

1.2 Report Scope

Food security and the food systems that underpin it have been, are, and will continue to be subject to change as a result of many factors, including changes in food production, trade arrangements, transportation systems, civil unrest, health, energy costs, economic status, and others, each operating on a variety of spatial and temporal levels. This report documents how food systems and food security have already responded and may continue to respond to a world affected by climate change. A discussion of the secondary effects of these changes upon other sectors (e.g., human health, national security) is outside the scope of this report, as is consideration of the effects of food systems on climate and the associated mitigation options. Policy recommendations are outside the scope of this report. Finally, the more specific issue of domestic U.S. food security has been detailed extensively elsewhere (Gundersen et al. 2011, Takle et al. 2013, USDA ERS 2013a) and is not the topic of this report.

This report addresses the spectrum of food security components: availability, access, utilization, and stability. While food production (including livestock, fisheries, and wild harvesting, in addition to crops) is clearly related to food availability, post-farm gate activities (food processing, packaging, transporting, storing, trading, wholesaling, retailing, consuming, and waste disposing) matter a great deal to comprehensive food-security outcomes. Each is considered within economic, social, and biophysical contexts.

The geographic scope of this report is global. Food-system activities and the food-security outcomes of these activities in relation to food availability, access, utilization, and their stability are highly interactive, both geographically and temporally. Because of these interdependencies and the shifting geography of food supplies and demands, any given nation's food security must be considered within the global context. Hence, the global scale was necessarily selected for this report.

1.3 Report Organization

This report examines what is currently known about climate's historical relationship to food security and the food system. This stock of knowledge is then applied to a scenario-based future of plausible outcomes, reflecting a range of plausible future assumptions regarding climate, the economy, and agricultural development over the next 20–100 years. The report is organized as follows:

- The **Executive Summary** affords an overview of the report's full content.
- The **Introduction** (this chapter) provides background and an orientation to the report's layout.
- **Key Concepts and Definitions** (Chapter 2) includes a general description of key concepts that are prevalent throughout the report and definitions of important terms.
- **Models, Scenarios, and Projections of Climate Change and Socioeconomic Change (**Chapter 3), summarizes recent projections and scenarios that describe how overall global climate and climate variables relevant to food security are likely to change under different levels of greenhouse-gas emissions and concentrations. It also describes alternative pathways of future socioeconomic change that could affect food vulnerability and response capabilities. These scenarios reflect a range of plausible future conditions against which risks, vulnerabilities, and opportunities may be assessed in an integrated fashion.
- **Integrated Assessment Modeling of Agricultural and Food Systems** (Chapter 4), describes global and regional modeling of climate-change effects on food production, agricultural land use, prices, and numbers of food-insecure people.
- **Food Availability and Stability** (Chapter 5), documents the relationships between climate

change and the parts of the food system relevant to availability of food supplies.

- **Food Access and Stability** (Chapter 6), documents the relationships between climate change and the parts of the food system relevant to people's access to food.

- **Food Utilization and Stability** (Chapter 7), documents the relationships between climate change and the parts of the food system relevant to people's utilization of food.

- **Global Food Security, Climate Change, and the United States** (Chapter 8), describes how climate change affects global food systems and how global food security could affect the food system of the United States.

- **Report Conclusions** (Chapter 9), describes the high-level findings that the authors have drawn from this assessment.

- Finally, a series of **appendices** lists author and technical contributors and their affiliations (Appendix A), commonly used abbreviations (Appendix B), a glossary (Appendix C), and the report's references (Appendix D).

1.4 Report-Development Process

USDA engaged USGCRP agencies with an initial "scoping session," identifying specific interests in the report. Additional stakeholders were engaged at an initiation workshop with the report authors in June 2013 to help scope the report and provide the most useful possible information to those communities most likely to make use of it.[1] A second stakeholder meeting was held during a session of the National Council for Science and the Environment in January 2014.[2] Overall, more than 50 stakeholder groups representing food-production groups, food-assistance organizations, financiers, private industry, nongovernmental representatives, the Federal service, and others were engaged in the initial scoping and development stages of the report. Participation by an additional 26 organizations was solicited.

This report had two types of technical content contributors. Report authors contributed text to one or more chapters, participated in building consensus to develop a coherent interpretation of the available technical materials across the range of the report's subject matter content, and arrived at the conclusions presented in Chapter 9. Technical contributors wrote text for individual chapters and participated in developing conclusions related to the subject matter of that chapter alone; technical contributors were not involved in developing the overall report conclusions. Report authors and technical contributors were chosen for their expertise and represent academic institutions, Federal service, and nongovernmental and intergovernmental organizations. Contributors of nontechnical information listed glossary terms and abbreviations for the appendices but did not participate in content development or the consensus process. A list of report authors, chapter technical contributors, and nontechnical contributors is provided in Appendix A.

Peer-reviewed documents and specific types of government or intergovernmental data sources (e.g., FAOSTAT) have been included in this evaluation. Trade journals, online documents or webpages that document the existence of a particular program, and other types of publications may contain information both useful and important to the subject matter of this report that is not generally available in the peer-reviewed technical literature. However, because those sources are not subject to peer-review standards, their quality and veracity can vary greatly. As a consequence, those sources are included here only in cases where a specific opinion or perspective is being represented as such and is consequently not in need of review verification.

The report was primarily drafted between October 2013 and October 2014. Expert peer reviewers were solicited via Federal Register in July and August 2014. 652 comments were responded to through peer review and interagency comment, followed by a public comment period in September 2015. A revised draft was submitted for Federal clearance in October 2015.

[1] http://www.globalchange.gov/sites/globalchange/files/Climate%20Change%20and%20Food%20Security%20Expert%20Stakeholder%20Mtg%20Summary%20%28Final%29.pdf

[2] http://www.buildingclimatesolutions.org/topics/view/523385840cf264abcce225e8/